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(54) **Natural language parsing method and apparatus**

Verfahren und Vorrichtung zur Analyse natürlicher Sprache

Procédé et dispositif d'analyse du langage naturel

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- **SENEFF S: "Robust parsing for spoken language systems" DIGITAL SIGNAL PROCESSING 2, ESTIMATION, VLSI. SAN FRANCISCO, MAR. 23 - 26, 1992, PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH AND SIGNAL PROCESSING (ICASSP), NEW YORK, IEEE, US, vol. 5 CONF. 17, 23 March 1992 (1992-03-23), pages 189-192, XP010058684 ISBN: 0-7803-0532-9**

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Description**Background and Summary of the Invention**

5 [0001] The present invention relates to speech analysis, and more particularly to a computer-implemented natural language parser.

[0002] Understanding the meaning of a natural language sentence is the cornerstone of many fields of science with implications as broad ranging as from how humans interact with computers or machines to how they can interact with other intelligent agents, human or machine, through translation systems. The task becomes more complicated when the sentence is obtained using an automatic speech recognition system (ASR), where recognition errors such as insertions, omissions or substitutions can render the sentence less intelligible even to a human. Additional user-interface related factors might also introduce an element of un-naturalness to the speakers own utterance, so that the recognized sentence may contain the affects of a user's hesitations; pauses, repetitions, broken phrase or sentences.

10 [0003] Due to these factors, parsing natural language sentences occupies an important area in computer-implemented speech related systems. However, current approaches for natural language parsers typically experience relatively sub-optimal robustness in handling the afore mentioned errors of an automatic speech recognition system.

[0004] In "A modular approach to spoken language translation for large domains", M. Woszczyna, et al. Proceedings of AMTA-1998 18-31 October 1998 pages 1 - 10, there is disclosed a machine translation system specifically suited for spoken dialogue in which language is characterized by highly disfluent utterances which can be fragmented and ungrammatical, and in which a lattice of parse trees that contain all possible domain actions is created, where a domain action can include an operation such as requesting information or giving information and consists of three representational levels: consistency of a speech act, concepts, and arguments.

15 [0005] The present invention overcomes the afore mentioned disadvantages as well as other disadvantages.

[0006] In accordance with the teachings of the present invention, a computer-implemented speech parsing method and apparatus for processing an input phrase is provided. The method and apparatus include providing a plurality of grammars that are indicative of predetermined topics. A plurality of parse forests are generated using the grammars, and tags are associated with words in the input phrase using the generated parse forests. Scores are generated for tags based upon attributes of the parse forests, and tags are selected for use as a parsed representation of the input phrase based upon the generated scores.

20 [0007] For a more complete understanding of the invention, its objects and advantages, reference should be made to the following specification and to the accompanying drawings.

Brief Description of the Drawings

35 [0008]

Figure 1 is a block diagram depicting the computer-implemented components utilized to effect a dialog between at least two people with different languages.

Figure 2 is a block diagram depicting the components of the system of Figure 1 in more detail;

40 Figure 3 is a tag generation diagram depicting the application of the semantic tag generation process to an input sentence;

Figure 4 is a block diagram depicting the components of the local parser of the present invention;

Figure 5 is a tag generation diagram depicting the application of the semantic tag generation process to an input sentence;

45 Figure 6 is a parse tree diagram depicting a model for a parse tree for an input sentence;

Figure 7 is a parse tree diagram depicting multiple tags being generated as candidates during intermediate stages of local parsing;

Figure 8 is a process diagram depicting the output at different intervals for the present invention;

Figure 9 is a computer screen display of an exemplary cost grammar;

50 Figure 10 is a computer screen display of a parse forest generated for an input sentence;

Figure 11 is a graphical parse forest showing a partial representation in a graphical format of the parse forest in Figure 10;

Figure 12 is a flow chart depicting the operational steps associated with the present invention being utilized in an exemplary application; and

55 Figure 13 is a flow chart depicting the operational steps associated with processing an input sentence using the local parser of the present invention.

Description of the Preferred Embodiment

[0009] Figure 1 depicts a computer-implemented dialog continuous speech processing system for allowing two people who speak different languages to effectively communicate. In the non-limiting example of Figure 1, a buyer 20 wishes to communicate with salesperson 22 in order to purchase a piece of merchandise. The difficulty arises in that buyer 20 speaks only English while salesperson 22 speaks only Japanese.

[0010] The dialog speech processing system 24 of the present invention uses a speech recognizer 26 to transform the English speech of buyer 20 into a string of words. The string of words is read as text by a speech understanding module 28 which extracts the semantic components of the string.

[0011] A dialog manager 30 determines whether a sufficient amount of information has been provided by buyer 20 based upon the semantic components determined by speech understanding module 28. If a sufficient amount of information has been provided, dialog manager 30 allows translation module 32 to translate the buyers speech from the determined semantic components to Japanese. Translation module 32 translates the semantic components into Japanese and performs speech synthesis via computer response module 42 in order to vocalize the Japanese translation for salesperson 22 to hear.

[0012] Salesperson 22 then utilizes the dialog speech processing system 24 to respond to buyer 20. Accordingly, a Japanese speech recognizer 36 and Japanese speech understanding module 38 respectively perform speech recognition of the speech of salesperson 22 if insufficient information has been provided by salesperson 22.

[0013] If dialog manager 30 determines that an insufficient amount of information has been provided by buyer 20 for accomplishing a predetermined goal (such as purchasing a piece of merchandise), dialog manager 30 instructs a computer response module 34 to vocalize a response which will ask buyer 20 to provide the missing piece(s) of information.

[0014] The preferred embodiment is suitable for implementation in a hand-held computer device 43 where the device is a tool allowing the user to formulate his or her request in the target language. Such a portable hand-held device is well suited for making a ticket/hotel reservation in a foreign country, purchasing a piece of merchandise, performing location directory assistance, or exchanging money. The preferred embodiment allows the user to switch from one task to another by selecting on the hand-held device which task they would like to perform. In an alternate embodiment, a flash memory card which is unique to each task can be provided so that a user can switch from one task to another.

[0015] Figure 2 depicts components of the dialog speech processing system 24 in more detail. In particular, speech understanding module 28 includes a local parser 60 to identify predetermined relevant task-related fragments. Speech understanding module 28 also includes a global parser 62 to extract the overall semantics of the buyer's request.

[0016] The novel local parser 60 utilizes in the preferred embodiment small and multiple grammars along with several passes and an unique scoring mechanism to provide parse hypotheses. For example, the novel local parser recognizes according to this approach phrases such as dates, names of cities, and prices. If a speaker utters "get me a flight to Boston on January 23rd which also serves lunch", the local parser recognizes: "Boston" as a city name; "January 23rd" as a date; and "lunch" as being about a meal. The global parser assembles those items (city name, date, etc.) together and recognizes that the speaker wishes to take an airplane ride with certain constraints.

[0017] Speech understanding module 28 includes knowledge database 63 which encodes the semantics of a domain (i.e., goal to be achieved). In this sense, knowledge database 63 is preferably a domain-specific database as depicted by reference numeral 65 and is used by dialog manager 30 to determine whether a particular action related to achieving a predetermined goal is possible.

[0018] The preferred embodiment encodes the semantics via a frame data structure 64. The frame data structure 64 contains empty slots 66 which are filled when the semantic interpretation of global parser 62 matches the frame. For example, a frame data structure (whose domain is purchasing merchandise) includes an empty slot for specifying the buyer-requested price for the merchandise. If buyer 20 has provided the price, then that empty slot is filled with that information. However, if that particular frame needs to be filled after the buyer has initially provided its request, then dialog manager 30 instructs computer response module 34 to ask buyer 20 to provide a desired price.

[0019] Preferably, computer response module 34 is multi-modal in being able to provide a response to a user via speech synthesis, text or graphical. For example, if the user has requested directions to a particular location, the computer response could display a graphical map with the terms on the map being translated by translation module 40. Moreover, computer response module 40 can speak the directions to the user through audio part 68. However, it is to be understood that the present invention is not limited to having all three modes present as it can contain one or more of the modes of the computer response module 34.

[0020] Audio part 68 uses the semantics that have been recognized to generate a sentence in the buyer's target language based on the semantic concept. This generation process preferably uses a paired dictionary of sentences in both the initial and target language. In an alternate embodiment, sentences are automatically generated based on per type sentences which have been constructed from the slots available in a semantic frame.

[0021] The frame data structure 64 preferably includes multiple frames which each in turn have multiple slots. One

frame may have slots directed to attributes of a shirt, such as, color, size, and prices. Another frame may have slots directed to attributes associated with the location to which the shirt is to be sent, such as, name, address, phone number.

[0022] The following reference discusses global parsers and frames: R. Kuhn and R. D. Mori, *Spoken Dialogues with Computers (Chapter 14: Sentence Interpretation)*, Academic Press, Boston (1998).

[0023] Dialog manager **30** uses dialog history data file **67** to assist in filling in empty slots before asking the speaker for the information. Dialog history data file **67** contains a log of the conversation which has occurred through the device of the present invention. For example, if a speaker utters "get me a flight to Boston on January 23rd which also serves lunch", the dialog manager **30** examines the dialog history data file **67** to check what city names the speaker may have mentioned in a previous dialog exchange. If the speaker had mentioned that he was calling from Detroit, then the dialog manager **30** fills the empty slot of the source city with the city name of "Detroit". If a sufficient number of slots have been filled, then the present invention will ask the speaker to verify and confirm the flight plan. Thus, if any assumptions made by the dialog manager **30** through the use of dialog history data file **67** prove to be incorrect, then the speaker can correct the assumption.

[0024] In another alternate embodiment computer response module **34** is instructed by dialog manager **30** to perform a search on the remote database **70** in order to provide buyer **20** with information about that piece of merchandise. In this non-limiting example, dialog manager **30** can instruct computer response module **34** to search the store's remote database **70** for the price range of the merchandise for which the buyer **20** is interested. The alternate embodiment substantially improves the quality of the dialog between buyer **20** and salesperson **22** by providing information to buyer **20** so that buyer **20** can formulate a more informed request to salesperson **22**.

[0025] Dialog manager **30** assumes an integral role in the dialog by performing a back-and-forth dialog with buyer **20** before buyer **20** communicates with salesperson **22**. In such a role, dialog manager **30** using the teachings of the present invention is able to effectively manage the turn-taking aspect of a human-like back-and-forth dialog. Dialog manager **30** is able to make its own decision about which direction the dialog with buyer **20** will take next and when to initiate when a new direction will be taken.

[0026] For example, if buyer **20** has requested a certain type of shirt within a specified price range, dialog manager **30** determines whether such a shirt is available within that price range. Such a determination is made via remote database **70**. In this example, dialog manager **30** determines that such a shirt is not available in the buyer's price range, however, another type of shirt is available in that price range. Thus, dialog manager **30** can determine whether a particular action or goal of the buyer is feasible and assist the buyer to accomplish that goal.

[0027] The present invention analyzes and extracts semantically important and meaningful topics from a loosely structured, natural language text which may have been generated as the output of an automatic speech recognition system (ASR) used by a dialogue or speech understanding system. The present invention translates the natural language text input to a new representation by generating well-structured tags containing topic information and data, and associating each tag with the segments of the input text containing the tagged information. In an alternate embodiment, tags are generated as a separate list, or as a semantic frame.

[0028] Figure 3 depicts a non-limiting example of the role of the local parser of the present invention in a speech understanding system such as, in an automated online travel reservation specialist with a speech interface. The following topics can be potential targets for the present invention: flight arrival and departure times, and dates possibly with ranges and constraints; city-names involved in the flight; fare/cost information involving currency amounts; class of seats; meal information; flight-numbers; names of airlines; the stop-overs of the flight, etc.

[0029] The example includes a possible input sentence **100** as generated from a continuous speech recognition system and containing recognition mistakes. The corresponding output **102** is a possible interpretation by the present invention where three tags have been generated, one corresponding to city-names **104**, one to time **106**, and one to date **108**.

[0030] Robustness is a feature of the present invention as the input can contain grammatically incorrect English sentences, such as in the example above, due to the following reasons: the input to the recognizer is casual, dialog style, natural speech and can contain broken sentences, partial phrases; the speech recognition may introduce insertion, omission, or mis-recognition errors even when the speech input is considered correct. The present invention deals robustly with all types of input and extracts as much information as possible.

[0031] Figure 4 depicts the different components of the novel local parser **60** of the present invention. The present invention preferably utilizes generalized parsing techniques in a multi-pass approach as a fixed-point computation. Each topic is described as a context-sensitive LR (left-right and rightmost derivation) grammar, allowing ambiguities. The following are references related to context-sensitive LR grammars: A. Aho and J. D. Ullman, *Principles of Compiler Design*, Addison Wesley Publishing Co., Reading, Massachusetts (1977); and N. Tomita, *Generalized LR Parsing*, Kluwer Academic Publishers, Boston, Massachusetts (1991).

[0032] At each pass of the computation, a generalized parsing algorithm is used to generate preferably all possible (both complete and partial) parse trees independently for each targeted topic. Each pass potentially generates several alternative parse-trees, each parse-tree representing a possibly different interpretation of a particular topic. The multiple

passes through preferably parallel and independent paths result in a substantial elimination of ambiguities and overlap among different topics. The present invention is a systematic way of scoring all possible parse-trees so that the (N) best candidates are selected utilizing the contextual information present in the system.

[0033] Local parsing system 60 is carried out in three stages: lexical analysis 120; parallel parse-forest generation for each topic (for example, generators 130 and 132); and analysis and synthesis of parsed components as shown generally by reference numeral 134. The preferred embodiment depicts the structure for the inputs to and outputs from the local parser in Exhibit A below.

Lexical analysis:

[0034] A speaker utters a phrase that is recognized by an automatic speech recognizer 117 which generates input sentence 118. Lexical analysis stage 120 identifies and generates tags for the topics (which do not require extensive grammars) in input sentence 118 using lexical filters 126 and 128. These include, for example, city-names; class of seats; meal information; names of airlines; and information about stop-overs. A regular-expression scan of the input sentence 118 using the keywords involved in the mentioned exemplary tags is typically sufficient at this level. Also, performed at this stage is the tagging of words in the input sentence that are not part of the lexicon of particular grammar. These words are indicated using an X-tag so that such noise words are replaced with the letter "X".

Parallel parse-forest generation:

[0035] The present invention uses a high-level general parsing strategy to describe and parse each topic separately, and generates tags and maps them to the input stream. Due to the nature of unstructured input text 118, each individual topic parser preferably accepts as large a language as possible, ignoring all but important words, dealing with insertion and deletion errors. The parsing of each topic involves designing context-sensitive grammar rules using a meta-level specification language, much like the ones used in LR parsing. Examples of grammars include grammar A 140 and grammar B 142. Using the present invention's approach, topic grammars 140 and 142 are described as if they were an LR-type grammar, containing redundancies and without eliminating shift and reduce conflicts. The result of parsing an input sentence is all possible parses based on the grammar specifications.

[0036] Generators 130 and 132 generate parse forests 150 and 152 for their topics. Tag-generation is done by synthesizing actual information found in the parse tree obtained during parsing.

[0037] Figure 4 depicts tag generation via tag and score generators 160 and 162 which respectively generate tags 164 and 166. Each identified tag also carries information about what set of input words in the input sentence are covered by the tag. Subsequently the tag replaces its cover-set. In the preferred embodiment, context information 167 is utilized for tag and score generations, such as by generators 160 and 162. Context information 167 is utilized in the scoring heuristics for adjusting weights associated with a heuristic scoring factor technique that is discussed below. Context information 167 preferably includes word confidence vector 168 and dialogue context weights 169. However, it should be understood that the present invention is not limited to using both word confidence vector 168 and dialogue context weights 169, but also includes using one to the exclusion of the other, as well as not utilizing context information 167 within the present invention.

[0038] Automatic speech recognition process block 117 generates word confidence vector 168 which indicates how well the words in input sentence 118 were recognized. Dialog manager 30 generates dialogue context weights 169 by determining the state of the dialogue. For example, dialog manager 30 asks a user about a particular topic, such as, what departure time is preferable. Due to this request dialog manager 30 determines that the state of the dialogue is time-oriented. Dialog manager 30 provides dialogue context weights 169 in order to inform the proper processes to more heavily weight the detected time-oriented words.

Synthesis of Tag-components:

[0039] The topic spotting parser of the previous stage generates a significant amount of information that needs to be analyzed and combined together to form the final output of the local parser. The present invention is preferably as "aggressive" as possible in spotting each topic resulting in the generation of multiple tag candidates. Additionally in the presence of numbers or certain key-words, such as "between", "before", "and", "or", "around", etc., and especially if these words have been introduced or dropped due to recognition errors it is possible to construct many alternative tag candidates. For example, the input sentence 220 in Figure 5 could have been a result of insertion or deletion errors. The combining phase of the present invention determines which tags form a more meaningful interpretation of the input. The present invention defines heuristics and makes a selection based on them using a N-Best candidate selection process. Each generated tag corresponds to a set of words in the input word string, called the tag's cover-set.

[0040] A heuristic is used that takes into account the cover-sets of the tags used to generate a score. The score

roughly depends on the size of the cover-set, the sizes in the number of the words of the gaps within the covered items, and the weights assigned to the presence of certain keywords. In the preferred embodiment, ASR-derived confidence vector and dialog context information are utilized to assign priorities to the tags. For example applying cost-tags parsing first potentially removes cost-related numbers that are easier to identify uniquely from the input stream, and leaves fewer numbers to create ambiguities with other tags. Preferably, dialog context information is used to adjust the priorities.

N-Best Candidates Selection

[0041] With reference back to Figure 4, at the end of each pass, an N-best processor 170 selects the N-best candidates based upon the scores associated with the tags and generates the topic-tags, each representing the information found in the corresponding parse-tree. Once topics have been discovered this way, the corresponding words in the input can be substituted with the tag information. This substitution transformation eliminates the corresponding words from the current input text. The output 180 of each pass is fed-back to the next pass as the new input, since the substitutions may help in the elimination of certain ambiguities among competing grammars or help generate better parse-trees by filtering out overlapping symbols.

[0042] Computation ceases when no additional tags are generated in the last pass. The output of the final pass becomes the output of the local parser to global parser 62. Since each phase can only reduce the number of words in its input and the length of the input text is finite, the number of passes in the fixed-point computation is linearly bounded by the size of its input.

[0043] The following novel scoring factors are used to rank the alternative parse trees based on the following attributes of a parse-tree:

- Number of terminal symbols.
- Number of non-terminal symbols.
- The depth of the parse-tree.
- The size of the gaps in the terminal symbols.
- ASR-Confidence measures associated with each terminal symbol.
- Context-adjustable weights associated with each terminal and non-terminal symbol.

Each path preferably corresponds to a separate topic that can be developed independently, operating on a small amount of data, in a computationally inexpensive way. The architecture of the present invention is flexible and modular so incorporating additional paths and grammars, for new topics, or changing heuristics for particular topics is straight forward, this also allows developing reusable components that can be shared among different systems easily.

[0044] Figure 6 provides a non-limiting depiction of a tree in relation to a discussion to the tag scoring heuristics. Figure 6 depicts an input string 250 and a sample parse-tree 252. The parse-tree rooted as St 254 identifies the subsequence {w3, w4, w7, w8, w10}, as a possible parse. This parse has 5 terminal symbols {w3, w4, w7, w8, w10}, with gaps between w4 & w7 (size=2) and between w8 and w10 (size= 1), or total gapsize of 3. Parse tree 252 has four non-terminals: St 254, NT_a 256, NT_b 258, and NT_c 260. The depth of parse tree 252 is three due to the traversal from St 254 to NT_i 258 to NT_a 256 to W3.

[0045] A possible score for this parse is:

$$\#Terminals * 10 - (\text{GapSize} * 1.5) - \text{Depth}$$

$$+ \#Non-terminals = 50 - 4.5 - 3 + 4 = 46.5$$

[0046] The present invention also includes utilizing non-uniform weights which can be assigned to the non-terminal and terminal nodes. Also, confidence measures are preferably utilized to adjust the weights of one or more of the scoring factors. For example, a likelihood ratio algorithm can be utilized to compute confidence scores (see, for example, the following reference: R. Sukkar and Chin-Hui Lee, *Vocabulary Independent Discriminative Utterance Verification for Non-Key Word Rejection in Sub-Word Based Speech Recognition*, IEEE Transactions on Speech and Audio Processing, Vol. 4, No. 6, pages 420-29 (1996)).

[0047] Figure 7 provides another non-limiting depiction of a tree in relation to a discussion to the scoring heuristics. Five parse trees are shown at reference numerals 270, 272, 274, 276, and 278. With respect to the five possible parse trees and corresponding tags shown in Figure 7, the following scoring approach is used:

#	Tag	#words	#NT	Depth	Gap	Score	Rank
1	Time[> 19:00]	3	2	2	7	$30+2-2-10.5 = 19.5$	4
2	Time[> 19:10]	4	3	3	10	$40+3-3-15 = 25.0$	2
3	Time[> 7:00]	2	1	1	1	$20+1-1-1.5 = 18.5$	5
4	Time[> 7:10]	3	2	2	4	$30+2-2-6 = 20.0$	3
5	Date[~6/10]	3	2	2	0	$30+2-2-0 = 30$	1

[0048] The score based system results in Tag#5 being picked as the best candidate for Date targets, this selection eliminates Tag#2 and Tag#4 from further consideration due to the overlap with Tag#1 lexicon. This leaves the parse for Tag#1 as the next best parse, so Tags #5 and #1 are selected.

[0049] The present invention utilizes multiple-passes as illustrated in Figure 8. At reference numeral 290, outputs of the present invention are depicted at different passes in processing input sentence 294. Parse tree forest 296 is generated during the first pass and helps to generate first pass output 298. First pass output 298 has associated time tag 300 with the words of input sentence 294 "Five thirty pm".

[0050] First pass output 298 is used as an input for a second pass processing of input sentence 294. Parse forest 302 is generated during processing of the second pass and results in a cost tag 304 being generated. In one embodiment of the present invention, the reason why the first pass processing did not parse the hundred dollars part of input sentence 294 is due to N-best tag selection and combining block 170 of Figure 4. During the first phase, due to lexical filtering and aggressive parsing, the best cost parse is "five hundred dollars", and the best time parse is parse tree forest 296 for "after five thirty p-m". Since the word "five" is shared, the selection process invalidates the best cost parse and generates the time tag for "five thirty p-m". However, the end of the second pass results in a filtered string 308 which generates the cost tag 304 successfully.

Grammar

[0051] In the preferred embodiment, each topic is expressed as a generalized LR(0) grammar using the following syntax:

```

TopicGrammar = Rule+.
Rule = "*" ID "." |
      ID "." |
      ID "=" ID* ("|" ID*)* "." |
      ID "." ID+ "."

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[0052] The grammar syntax informally states that the grammar is expressed as a series of grammar rules, where each grammar rule either describes a context-sensitive substitution rule for a terminal or a non-terminal grammar symbol.

[0053] Figure 9 depicts an exemplary grammar for parsing the cost involving dollar or yen amounts. The first rule <* COST.> 320 declares the root non-terminal symbol to be COST.

[0054] Each subsequent rule of the form <A = X Y Z.> specifies a non-terminal symbol, A, and a substitution rule where the symbol A can be substituted in a rightmost derivation by the three right hand side grammar symbols, X Y Z, each of which is either a terminal or non-terminal symbol. For example, the rule 324:

C_Gen = C_Num | C_Num C_Currency.

defines C_Gen as a non-terminal that can be reduced with either a number (C_Num) or a number followed by a currency symbol (C_Currency). Terminal symbols are defined using the <t: s1 s2.> For example, the rule 328:

c_yen: yen yens.

defines c_yen to be a terminal symbol matching the "yen" or "yens" as a next token in the input stream.

[0055] The cost grammar matches all words that are not defined as terminals under the X rule. A lexical filter is used to convert all input words that are not relevant to COST rules with the word "x". Accordingly, the X rule matches one or more consecutive "x"s.

[0056] Figure 10 shows a non-limiting example of parsing the sentence 400: "flights under five hundred dollars." Each line represents the application of a grammar rule, for example at reference numeral 404:

C_Tens_2_3=c_num_2_3.

represents a node in the parse forest where the grammar symbol C_Tens covers the range [2-3], i.e. the word "five". Similarly line 408:

c_qualifier_1_2: "under".

represents terminal symbol $c_qualifier$ matching the range [1-2], i.e. the word "under". The root symbol rule 412, COST_0_5 covers the entire range signalling a successful parse which yielded a unique parse for the entire input. Other root symbols rules are depicted which have their own parse trees shown in Figure 10. For example, Figure 10 depicts a parse tree for root symbol 437. If multiple parses are used, a rule contains the alternatives shown with "I" s. Also notice in a non-limiting manner how the first word, "flights", is skipped over by the X rule.

[0057] Figure 11 shows a partial graphical tree depiction of the data of Figure 10. For example, root symbol rule is depicted by reference numeral 412 on Figure 11.

Tag Generation:

[0058] The preferred tag generation method uses a parse forest, and generates the tags as specified by the output specifications. The tag generation algorithm (called reduce) uses a synthesis and inheritance approach in order to construct each tag utilizing the information found in the parse tree (note: the usage of the name "reduce" herein is separate and different from the term reduce (as in shift/reduce actions) used in the LR parsing literature). The reduce algorithm used by the tag generation method operates as follows:

Input: node: α_i_j (any node in the parse forest.)

1. If α_i_j is a terminal rule, return the right-hand-side (which is a token at the input stream at position i) either unchanged, or by assigning it a meaning - for example applying a conversion from ascii to numeric for a digit, etc.,)

2. remove all the X-rules from the right-hand-side, yielding a rule of the form

$$\alpha_i_j = \beta_{o_j_o} \beta_{l_i_l} \beta_{k_j_k}$$

where $\beta \neq X$.

3. Evaluate new attribute, α , for α_i_j by concatenating results from reducing the terms on the right-hand-side, i.e.:

$$\alpha_i_j.\alpha = \sum_{l=o..k} \text{reduce}(\beta_{l_i_l})$$

where: Σ is a concatenation operator.

4. Inherit all the attributes from each reduced term on the right-hand-side.

for each term, $\beta_{l_i_l}$ in the right-hand-side

for each attribute, $\phi \in \beta_{l_i_l}.\text{AttrList}$

add ϕ to the node's attribute list:

$$\alpha_i_j.\text{AttrList} \cup = \phi$$

inherit the attribute value:

$$\alpha_i_j.\phi = \beta_{l_i_l}.\phi$$

5. If necessary generate new attributes for α_i_j possibly utilizing the inherited and computed attributes. All new attributes are inherited by the parent nodes, all the way up to the root node. This is the general mechanism by which we can construct and initialize the tag structures.

[0059] Figure 12 depicts operation of the present invention within an exemplary application of a buyer attempting to buy a particular shirt while speaking in a first language to a seller who speaks in a second language. The start indication block 500 indicates process block 504 is to be processed. At process block 504, the buyer speaks in a first language about a particular shirt. At process block 508, the buyer's speech is recognized and predetermined parts of the buyer's speech is determined via the local parser of the present invention at process block 512.

[0060] Process block 516 determines the semantic portions of the buyer's speech via a global parser. Process block 520 translates the determined semantic parts to a second language which is then vocalized at process block 524. At

process block 528, any response from the salesperson or buyer is processed according to the present invention. Processing terminates at process block 532.

[0061] Figure 13 depicts the operational steps associated with the multi-pass architecture of the local parser of the present invention. Start indication block 550 indicates that process block 554 is to be executed wherein an input sentence is received. Process block 567 performs automatic speech recognition for the input sentence.

[0062] Iteration block 566 performs for each grammar the following steps. Preferably, the processing for each grammar is performed substantially concurrently with the processing for a second grammar. Process block 570 utilizes a lexical filter on the input sentence using the grammar as selected by iteration block 566.

[0063] Process block 574 generates a parse forest using the selected grammar, and process block 578 generates tags for the input sentence using confidence vectors from process block 557 and using dialogue context weights from process block 599 (if available from previous processing of the dialogue manager). It is to be understood, however, that the present invention is not limited to using context-related data at this stage in processing, but also includes utilizing no context information at this stage.

[0064] Process block 582 generates a score for the tags that were generated at process block 578. Process block 586 selects the N-best tags based upon the score generated by process block 582. Process block 590 generates the tag output, and iteration terminator block 594 repeats the process until each grammar has been utilized.

[0065] If each grammar has been utilized for a particular pass, then decision block 598 inquires whether any additional tags have been generated. If additional tags have been generated, then processing continues at iteration block 566. If no additional tags were generated, then processing continues at process block 599. At process block 599, global parsing is performed, and then the dialog manager processing is performed wherein context weights are determined that could be used, if needed, in the next processing of an input sentence. Processing terminates at end block 602.

[0066] While the invention has been described in its presently preferred form, it is to be understood that there are numerous applications and implementations for the present invention. Accordingly, the invention is capable of modification and changes without departing from the spirit of the invention as set forth in the appended claims.

EXHIBIT A

[0067] **Input:** Ascii-text string, s , containing a sequence of white-space separated words, w_i , without any punctuation marks. The words are comprised of lower-case letters of English alphabet and the single-quote character. [note: no digits]

where

$$s = w_0 w_1 \dots w_n$$

$$w = [a-z]' +$$

[0068] **Output:** Ascii-text string, out , containing a sequence of white-space separated words or tags without punctuation marks.

where out = wt₀ wt₁ ... wt_m

wt = w|t

w = [a-z']⁺

t = dateTag |
 timeTag |
 costTag |
 flightNumTag |
 cityNameTag |
 airlineTag |
 stopTag |
 classTag |
 mealTag |
 typeTag

dateTag = DATE[d] | ; plain date
 DATE[d-d] | ; date range
 DATE[< d] | ; before date
 DATE[> d] | ; after date
 DATE[~ d] | ; around date
 DATE[d] | DATE[d] | ; alternative dates
 DATE[MIN()] | ; earliest date

d = dy/mo | ; date=day &

month

```

month
X/mo
; any day of the

dy = 1|2|3| ... | 31
mo = 1|2| ... | 12

timeTag = TIME[t] | ; plain time
          TIME[t-t] | ; time range
          TIME[< t] | ; before time
          TIME[> t] | ; after time
          TIME[~ t] | ; around time
          TIME[t] || TIME[t] ; alternative times
          TIME[MIN()] ; earliest
          TIME[MAX()] ; latest

t = hrs:min
time=hrs:minutes

hrs = 1|2|3| ... | 24
min = 01|02| ... | 59

costTag = COST[c] | ; plain cost
          COST[c-c] | ; cost range
          COST[< c] | ; under the amount
          COST[> c] | ; over the amount
          COST[~ c] | ; around cost
          COST[MIN()] ; cheapest
          COST[MAX()] ; most expensive

c = amountY | ; amount in
yens
amount$ ; amount in
dollars

amount = 1|2|3| ... | 99999

flightNumTag = FNUM[fnum]
fnum = 1|2|3| ... | 9999

cityNameTag = CITY[cityName]

cityName = ATLANTA | BALTIMORE BANGKOK | BOSTON
          CHICAGO | DALLAS | DENVER | HONG KONG |
          HOUSTON | LOS_ANGELES | L_A | MIAMI |

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NEW_ORLEANS | NEW_YORK |
NEW_YORK_CITY |
5 OAKLAND | OSAKA | PHILADELPHIA | SEOUL
|
PITTSBURGH | SAN_FRANCISCO |
WASHINGTON |
10 SINGAPORE | TOKYO | TORONTO |
VANCOUVER |

airlineTag = CITY[airlineName]

15 airlineName = AMERICAN_AIRLINES | U_S_AIR
|
JAPAN_AIRLINES |
CONTINENTAL |
20 UNITED | SINGAPORE_AIRLINES

stops stopTag = STOP[> 0] | ; any # of
STOP[= 0] ; non-stop

25 classTag = CLAS[class] ; class
class = first | business | economy

30 mealTag = MEAL[meal] ; meal info
meal = dinner | lunch | breakfast

typeTag = TYPE[oneway] | TYPE[round trip]
35

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Claims

- 40 1. A computer-implemented speech parsing method for processing an input phrase (118), comprising the steps of:
 - (a) providing a plurality of grammars (140, 142) indicative of pre-determined topics;
 - 45 (b) generating a plurality of parse forests (150, 152) related to said input phrase (118) using said grammars;
 - (c) associating tags (164, 166) with words in said input phrase (118) using said generated parse forests (150, 152);
 - 50 (d) generating scores for said tags (164, 166) based upon attributes of said parse forests (150, 152); and
 - (e) selecting tags (164, 166) for use as a parsed representation (180) of said input phrase (118) based upon said generated scores.
- 55 2. The speech parsing method of Claim 1 further comprising the step of:
 - performing said step (b) a plurality of iterations so that each iteration produces alternate parse forests.
3. The speech parsing method of Claim 1 wherein said step (b) is performed substantially concurrently for each of

said grammars.

4. The speech parsing method of Claim 3 further comprising the step of:
5 performing said step (b) a plurality of iterations wherein each iteration produces alternate parse forests with respect to each of said grammars.
5. The speech parsing method of Claim 1 further comprising the step of:
10 generating scores for said tags based upon score based factors selected from the group consisting of number of terminals, gap size, depth, number of non terminals, and combinations thereof.
6. The speech parsing method of Claim 5 further comprising the step of:
15 weighting at least two of said factors differently.
7. The speech parsing method of Claim 6 further comprising the step of:
20 using context information to weigh at least two of said factors differently.
8. The speech parsing method of Claim 7 further comprising the steps of:
generating a word confidence vector for said input phrase substantially during speech recognition of said input phrase; and
25 weighting at least two of said factors differently based upon said generated word confidence vector.
9. The speech parsing method of Claim 7 or 8 further comprising the steps of:
30 generating a request for information related to a pre-determined topic;
generating dialogue context weights based upon said generated request for information; and
weighting at least two of said factors differently based upon said generated dialogue context weights.
35
10. The speech parsing method of Claim 7 further comprising the steps of:
using said context information processor substantially in parallel to perform said step (b).
- 40 11. The speech parsing method of Claim 1 further comprising the steps of:
generating scores for said tags; and
selecting N-best tags for use in said parsed representation based upon said generated scores.
45
12. The speech parsing method of Claim 11 further comprising the steps of:
performing said steps (b) and (c) a plurality of iterations; and
50 using said selected N-best tags of a first iteration as input related to processing said steps (b) and (c) of a second iteration.
13. The speech parsing method of Claim 1 wherein said tags are indicative of said topics of said grammars.
- 55 14. The speech parsing method of Claim 1 wherein said input phrase is grammatically incorrect with respect to at least a portion of said input phrase, said method further comprising the steps of:
generating a plurality of parse forests related to said grammatically incorrect input phrase using said grammars;

associating tags with words in said grammatically incorrect input phrase using said generated parse forests;
and

using said tags associated with said words as a parsed representation of said grammatically incorrect input phrase.

15. The speech parsing method of Claim 1 wherein said grammars are based upon left-right context-sensitive grammars.

16. The speech parsing method of Claim 1 wherein said grammars are based upon left-right context-sensitive grammars and contain ambiguities.

17. The speech parsing method of Claim 1 further comprising the steps of:

filtering said input phrase via lexical filters; and

generating said plurality of parse forests based upon said filtered input phrase.

18. The speech parsing method of Claim 1 further comprising the step of:

extracting semantic components of said input phrase based upon said tags that are associated with said words.

19. The speech method of Claim 1 further comprising the step of:

providing a global parser to extract said semantic components from said input phrase based upon said tags that are associated with said words.

20. The speech parsing method of Claim 19 further comprising the step of:

managing based upon said extracted semantic components the exchange of dialogue between a speech recogniser device and a user.

21. The speech parsing method of Claim 19 further comprising the step of

managing based upon said extracted semantic components the exchange of dialogue between two users who speak different languages.

22. A computer-implemented speech parsing apparatus for processing an input phrase, comprising:

means for providing a plurality of grammars (140, 142) indicative of pre-determined topics;

a parse forest generator for generating a plurality of parse forests (150, 152) related to said input phrase (118) using said grammars;

a tag generator for associating tags (164, 166) with words in said input phrase (118) using said generated parse forests (150, 152);

a tag score generator for generating scores for said tags (164, 166) based upon attributes of said parse forests; and

a tag selector for selecting tags for use as a parsed representation (180) of said input phrase (118) based upon said generated scores.

23. The speech parsing apparatus of Claim 22 wherein said parse forest generator is executed a plurality of iterations such that each iteration produces alternate parse forests.

24. The speech parsing apparatus of Claim 22 wherein said parse forest generator is executed a plurality of iterations such that each iteration produces alternate parse forests with a respect to each of said grammars.

25. The speech parsing apparatus of Claim 22 wherein said tag score generator generates scores for said tags based upon score based factors selected from the group consisting of number of terminals, gap size, depth, number of non-terminals, and combinations thereof.
- 5 26. The speech parsing apparatus of Claim 25 wherein said tag score generator weights at least two of said factors differently.
27. The speech parsing apparatus of Claim 26 wherein said tag score generator uses context information to weight at least two of said factors differently.
- 10 28. The speech parsing apparatus of Claim 27 further comprising:
- a speech recognition module for performing speech recognition of said input phrase and for generating a word confidence vector for said input phrase substantially,
- 15 said tag score generator weighting at least two of said factors differently based upon said generated word confidence vector.
29. The speech parsing apparatus of Claim 27 or 28 further comprising:
- 20 a dialogue manager for generating a request for information related to a pre-determined topic, said dialogue manager generating dialogue context weights based upon said generated request for information, said tag score generator weighting at least two of said factors differently based upon said generated dialogue context weights.
- 25 30. The speech parsing apparatus of Claim 22 further comprising:
- a tag score generator for generating scores for said tags; and
- 30 a tag selector for selecting N-best tags for use in said parsed representation based upon said generated scores.
31. The speech parsing apparatus of Claim 30 wherein said parsed forest generator and tag generator are executed a plurality of iterations, said selected N-best tags of a first iteration are used as input to said parse forest generator and said tag generator during a second iteration.
- 35 32. The speech parsing apparatus of Claim 22 wherein said tags are indicative of said topics of said grammars.
33. The speech parsing apparatus of Claim 22 wherein said input phrase is grammatically incorrect with respect to at least a portion of said input phrase, said parse forest generators generating a plurality of parse forests related to said grammatically incorrect input phrase using said grammars, said tag
- 40 generator associating tags with words in said grammatically incorrect input phrase using said generated parse forests, said tags being associated with said words as a parsed representation of said grammatically incorrect input phrase.
- 45 34. The speech parsing apparatus of Claim 22 wherein said grammars are based upon left-right context-sensitive grammars.
35. The speech parsing apparatus of Claim 22 wherein said grammars are based upon left-right context-sensitive grammars and contain ambiguities.
- 50 36. The speech parsing apparatus of Claim 22 further comprising:
- a lexical filter for filtering said input phrase, said parse forest generator generating said plurality of parse forests based upon said filtered input phrase.
- 55 37. The speech parsing apparatus of Claim 22 further comprising:
- a semantic extractor for extracting semantic components of said input phrase based upon said tags that are

associated with said words.

38. The speech parsing apparatus of Claim 37 further comprising:

5 a global parser to extract said semantic components from said input phrase based upon said tags that are associated with said words.

39. The speech parsing apparatus of Claim 38 further comprising:

10 a dialogue manager for managing based upon said extracted semantic components the exchange of dialogue between a speech recogniser device and a user.

40. The speech parsing apparatus of Claim 39 further comprising:

15 a dialogue manager for managing based upon said extracted semantic components the exchange of dialogue between two users who speak different language.

Patentansprüche

20

1. Computerimplementiertes Sprachanalyseverfahren zum Verarbeiten einer Eingangsphrase (118), das folgende Schritte umfasst:

25

(a) Bereitstellen einer Vielzahl von Grammatiken (140, 142), die für vorbestimmte Themen indikativ sind;

(b) Generieren einer Vielzahl von mit der Eingangsphrase (118) verwandten Parsewäldern (150, 152) unter Verwendung der Grammatiken;

30

(c) Assoziieren von Etiketten (164, 166) mit Wörtern in der Eingangsphrase (118) unter Verwendung der generierten Parsewälder (150, 152);

(d) Generieren von Bewertungen für die Etiketten (164, 166), basierend auf Attributen der Parsewälder (150, 152); und

35

(e) Auswählen von Etiketten (164, 166) zur Verwendung als geparte Darstellung (180) der Eingangsphrase (118), basierend auf den generierten Bewertungen.

2. Sprachanalyseverfahren nach Anspruch 1, das weiter folgenden Schritt umfasst:

40

Ausführen des Schritts (b) über eine Vielzahl von Iterationen, so dass jede Iteration andere Parsewälder produziert.

3. Sprachanalyseverfahren nach Anspruch 1, wobei der Schritt (b) im Wesentlichen gleichzeitig für jede der Grammatiken ausgeführt wird.

45

4. Sprachanalyseverfahren nach Anspruch 3, das weiter folgenden Schritt umfasst:

Ausführen des Schritts (b) für eine Vielzahl von Iterationen, wobei jede Iteration andere Parsewälder bezüglich jeder der Grammatiken produziert.

50

5. Sprachanalyseverfahren nach Anspruch 1, das weiter folgenden Schritt umfasst:

Generieren von Bewertungen für die Etiketten, basierend auf bewertungsbasierten Faktoren, die aus der Anzahl von Endstellen, Lückengröße, Tiefe, Anzahl von Nicht-Endstellen und Kombinationen derselben bestehenden Gruppe ausgewählt werden.

55

6. Sprachanalyseverfahren nach Anspruch 5, das weiter folgenden Schritt umfasst:

unterschiedliches Gewichten von mindestens zwei der Faktoren.

7. Sprachanalyseverfahren nach Anspruch 6, das weiter folgenden Schritt umfasst:

5 Verwenden von Kontextinformationen zum unterschiedlichen Gewichten von mindestens zwei der Faktoren.

8. Sprachanalyseverfahren nach Anspruch 7, das weiter folgende Schritte umfasst:

10 Generieren eines Wortvertrauensvektors für die Eingangsphrase, im Wesentlichen während der Spracherkennung der Eingangsphrase; und

unterschiedliches Gewichten von mindestens zwei der Faktoren, basierend auf dem generierten Wortvertrauensvektor.

- 15 9. Sprachanalyseverfahren nach Anspruch 7 oder 8, das weiter folgende Schritte umfasst:

Generieren einer Anforderung nach Informationen, zusammenhängend mit einem vorbestimmten Thema;

20 Generieren von Dialogkontextgewichten, basierend auf der generierten Anforderung nach Informationen; und

unterschiedliches Gewichten von mindestens zwei der Faktoren, basierend auf den generierten Dialogkontextgewichten.

- 25 10. Sprachanalyseverfahren nach Anspruch 7, das weiter folgende Schritte umfasst:

Verwenden des Kontextinformationsprozessors, im Wesentlichen parallel, um den Schritt (b) auszuführen.

11. Sprachanalyseverfahren nach Anspruch 1, das weiter folgende Schritte umfasst:

30 Generieren von Bewertungen für die Etiketten; und

Auswählen von N-besten Etiketten für die Verwendung in der geparteten Darstellung, basierend auf den generierten Bewertungen.

- 35 12. Sprachanalyseverfahren nach Anspruch 11, das weiter folgende Schritte umfasst:

Ausführen der Schritte (b) und (c) über eine Vielzahl von Iterationen; und

40 Verwenden der ausgewählten N-besten Etiketten einer ersten Iteration als Eingabe, zusammenhängend mit der Verarbeitung der Schritte (b) und (c) einer zweiten Iteration.

13. Sprachanalyseverfahren nach Anspruch 1, wobei die Etiketten indikativ für die Themen der Grammatiken sind.

- 45 14. Sprachanalyseverfahren nach Anspruch 1, wobei die Eingangsphrase bezüglich mindestens eines Teils der Eingangsphrase grammatikalisch inkorrekt ist, wobei das Verfahren weiter folgende Schritte umfasst:

Generieren, unter Verwendung der Grammatiken, einer Vielzahl von Parsewäldern, zusammenhängend mit der grammatikalisch inkorrekten Eingangsphrase;

50 Assoziieren von Etiketten mit Wörtern in der grammatikalisch inkorrekten Phrase unter Verwendung der generierten Parsewälder; und

Verwenden der mit den Wörtern assoziierten Etiketten als analysierte Darstellung der grammatikalisch inkorrekten Eingangsphrase.

55

15. Sprachanalyseverfahren nach Anspruch 1, wobei die Grammatiken auf links-rechts kontextsensitiven Grammatiken basieren.

16. Sprachanalyseverfahren nach Anspruch 1, wobei die Grammatiken auf links-rechts kontextsensitiven Grammatiken basieren und Mehrdeutigkeiten enthalten.
- 5 17. Sprachanalyseverfahren nach Anspruch 1, das weiter folgende Schritte umfasst:
- Filtern der Eingangsphrase über lexikalische Filter; und
- Generieren der Vielzahl von Parsewäldern, basierend auf der gefilterten Eingangsphrase.
- 10 18. Sprachanalyseverfahren nach Anspruch 1, das weiter folgenden Schritt umfasst:
- Ausziehen semantischer Komponenten der Eingangsphrase, basierend auf den Etiketten, die mit den Wörtern assoziiert sind.
- 15 19. Sprachanalyseverfahren nach Anspruch 1, das weiter folgenden Schritt umfasst:
- Bereitstellen eines globalen Parsers zum Ausziehen der semantischen Komponenten aus der Eingangsphrase, basierend auf den Etiketten, die mit den Wörtern assoziiert sind.
- 20 20. Sprachanalyseverfahren nach Anspruch 19, das weiter folgenden Schritt umfasst:
- Verwalten, basierend auf den ausgezogenen semantischen Komponenten, des Austauschs von Dialog zwischen einer Spracherkennungsvorrichtung und einem Anwender.
- 25 21. Sprachanalyseverfahren nach Anspruch 19, das weiter folgenden Schritt umfasst:
- Verwalten, basierend auf den ausgezogenen semantischen Komponenten, des Austauschs von Dialog zwischen zwei Anwendern, die verschiedene Sprachen sprechen.
- 30 22. Computerimplementierte Sprachanalysevorrichtung zum Verarbeiten einer Eingangsphrase, die folgendes umfasst:
- Mittel zum Bereitstellen einer Vielzahl von Grammatiken (140, 142), die für vorbestimmte Themen indikativ sind;
- 35 einen Parsewaldgenerator zum Generieren einer Vielzahl von Parsewäldern (150, 152), zusammenhängend mit der Eingangsphrase (118) unter Verwendung der Grammatiken;
- 40 einen Etikettengenerator zum Assoziieren von Etiketten (164, 166) mit Wörtern in der Eingangsphrase (118), unter Verwendung der generierten Parsewälder (150, 152);
- einen Etikettenbewertungsgenerator zum Generieren von Bewertungen für die Etiketten (164, 166), basierend auf Attributen der Parsewälder; und
- 45 einen Etikettenauswähler zum Auswählen von Etiketten zur Verwendung als geparte Darstellung (180) der Eingangsphrase (118), basierend auf den generierten Bewertungen.
23. Sprachanalysevorrichtung nach Anspruch 22, wobei der Parsewaldgenerator über eine Vielzahl von Iterationen ausgeführt wird, so dass jede Iteration andere Parsewälder produziert.
- 50 24. Sprachanalysevorrichtung nach Anspruch 22, wobei der Parsewaldgenerator über eine Vielzahl von Iterationen ausgeführt wird, so dass jede Iteration andere Parsewälder bezüglich jeder der Grammatiken produziert.
- 55 25. Sprachanalysevorrichtung nach Anspruch 22, wobei der Etikettenbewertungsgenerator, basierend auf bewertungsbasierten Faktoren, die aus der Anzahl von Endstellen, Lückengröße, Tiefe, Anzahl von Nicht-Endstellen und Kombinationen derselben bestehenden Gruppe ausgewählt werden, Bewertungen für die Etiketten generiert.
26. Sprachanalysevorrichtung nach Anspruch 25, wobei der Etikettenbewertungsgenerator mindestens zwei der Fak-

toren unterschiedlich gewichtet.

27. Sprachanalysevorrichtung nach Anspruch 26, wobei der Etikettenbewertungsgenerator Kontextinformationen nutzt, um mindestens zwei der Faktoren unterschiedlich zu gewichten.

28. Sprachanalysevorrichtung nach Anspruch 27, der weiter folgendes umfasst:

ein Spracherkennungsmodul zum Ausführen von Spracherkennung der Eingabephase und zum Generieren eines Wortvertrauensvektors für die Eingangsphrase, wobei im Wesentlichen der Etikettenbewertungsgenerator mindestens zwei der Faktoren, basierend auf dem generierten Wortvertrauensvektor unterschiedlich gewichtet.

29. Sprachanalysevorrichtung nach Anspruch 27 oder 28, der weiter folgendes umfasst:

einen Dialogverwalter zum Generieren einer Anforderung nach Informationen, zusammenhängend mit einem vorbestimmten Thema, wobei der Dialogverwalter Dialogkontextgewichte, basierend auf der generierten Anforderung nach Informationen generiert, wobei der Etikettenbewertungsgenerator mindestens zwei der Faktoren, basierend auf den generierten Dialogkontextgewichten unterschiedlich gewichtet.

30. Sprachanalysevorrichtung nach Anspruch 22, der weiter folgendes umfasst:

einen Etikettenbewertungsgenerator zum Generieren von Bewertungen für die Etiketten; und

einen Etikettenauswähler zum Auswählen von N-besten Etiketten für die Verwendung in der geparsten Darstellung, basierend auf den generierten Bewertungen.

31. Sprachanalysevorrichtung nach Anspruch 30, wobei der Parsewaldgenerator und der Etikettengenerator über eine Vielzahl von Iterationen ausgeführt werden, wobei die ausgewählten N-besten Etiketten einer ersten Iteration als Eingabe für den Parsewaldgenerator und den Etikettengenerator während einer zweiten Iteration verwendet werden.

32. Sprachanalysevorrichtung nach Anspruch 22, wobei die Etiketten indikativ für die Themen der Grammatiken sind.

33. Sprachanalysevorrichtung nach Anspruch 22, wobei die Eingangsphrase bezüglich mindestens eines Teils der Eingangsphrase grammatikalisch inkorrekt ist, wobei die Parsewaldgeneratoren unter Verwendung der Grammatiken eine Vielzahl von Parsewäldern, zusammenhängend mit der grammatikalisch inkorrekten Eingangsphrase generieren, wobei der Etikettengenerator unter Verwendung der generierten Parsewälder Etiketten mit Wörtern in der grammatikalisch inkorrekten Phrase assoziiert, wobei die Etiketten als geparste Darstellung der grammatikalisch inkorrekten Eingangsphrase mit den Wörtern assoziiert werden.

34. Sprachanalysevorrichtung nach Anspruch 22, wobei die Grammatiken auf links-rechts kontextsensitiven Grammatiken basieren.

35. Sprachanalysevorrichtung nach Anspruch 22, wobei die Grammatiken auf links-rechts kontextsensitiven Grammatiken basieren und Mehrdeutigkeiten enthalten.

36. Sprachanalysevorrichtung nach Anspruch 22, die weiter folgendes umfasst:

einen lexikalischen Filter zum Filtern der Eingangsphrase, wobei der Parsewaldgenerator die Vielzahl von Parsewäldern, basierend auf der gefilterten Eingangsphrase generiert.

37. Sprachanalysevorrichtung nach Anspruch 22, die weiter folgendes umfasst:

einen semantischen Extraktor zum Ausziehen semantischer Komponenten aus der Eingangsphrase, basierend auf den Etiketten, die mit den Wörtern assoziiert sind.

38. Sprachanalysevorrichtung nach Anspruch 37, die weiter folgendes umfasst:

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einen globalen Parser zum Ausziehen der semantischen Komponenten aus der Eingangsphrase, basierend auf den Etiketten, die mit den Wörtern assoziiert sind.

39. Sprachanalysevorrichtung nach Anspruch 38, die weiter folgendes umfasst:

einen Dialogverwalter zum Verwalten, basierend auf den ausgezogenen semantischen Komponenten, des Austauschs von Dialog zwischen einer Spracherkennungsvorrichtung und einem Anwender.

40. Sprachanalysevorrichtung nach Anspruch 39, die weiter folgendes umfasst:

einen Dialogverwalter zum Verwalten, basierend auf den ausgezogenen semantischen Komponenten, des Austauschs von Dialog zwischen zwei Anwendern, die verschiedene Sprachen sprechen.

Revendications

1. Procédé d'analyse de la parole mis en oeuvre par ordinateur, servant à traiter une phrase à l'entrée (118), comportant les étapes qui consistent

(a) à fournir une pluralité de grammaires (140, 142) indiquant des sujets prédéterminés;

(b) à produire une pluralité de forêts d'analyse (150, 152) liées à cette phrase à l'entrée (118) en utilisant ces grammaires;

(c) à associer des étiquettes (164, 166) avec des mots dans la phrase à l'entrée (118) en utilisant ces forêts d'analyse produites (150, 152);

(d) à produire des scores pour ces étiquettes (164, 166) sur la base des attributs de ces forêts d'analyse (150, 152); et

(e) à sélectionner des étiquettes (164, 166) qui seront utilisées comme représentation analysée (180) de cette phrase à l'entrée (118) sur la base de ces scores produits.

2. Procédé d'analyse de la parole selon la revendication 1, comportant par ailleurs l'étape qui consiste à effectuer l'étape (b) avec une pluralité d'itérations de sorte que chaque itération produit d'autres forêts d'analyse.

3. Procédé d'analyse de la parole selon la revendication 1, **caractérisé en ce que** l'étape (b) s'effectue de manière essentiellement simultanée pour chacune des grammaires.

4. Procédé d'analyse de la parole selon la revendication 3, comportant par ailleurs l'étape qui consiste à effectuer l'étape (b) avec une pluralité d'itérations, **caractérisé en ce que** chaque itération produit d'autres forêts d'analyse relativement à chacune des grammaires.

5. Procédé d'analyse de la parole selon la revendication 1, comportant par ailleurs l'étape qui consiste à produire des scores pour ces étiquettes sur la base de certains facteurs fonction des scores qui sont sélectionnés dans le groupe composé du nombre de terminaux, de la taille des intervalles, de la profondeur, du nombre de non-terminaux, et de combinaisons de ceux-ci.

6. Procédé d'analyse de la parole selon la revendication 5, comportant par ailleurs l'étape qui consiste à pondérer au moins deux de ces facteurs de manière différente.

7. Procédé d'analyse de la parole selon la revendication 6, comportant par ailleurs l'étape qui consiste à utiliser l'information de contexte pour pondérer au moins deux de ces facteurs de manière différente.

8. Procédé d'analyse de la parole selon la revendication 7, comportant par ailleurs les étapes qui consistent à produire un vecteur de confiance dans les mots pour la phrase à l'entrée essentiellement pendant la reconnaissance vocale de la phrase à l'entrée; et

à pondérer au moins deux de ces facteurs de manière différente sur la base du vecteur de confiance dans les mots qui a été produit.

- 5 9. Procédé d'analyse de la parole selon la revendication 7 ou la revendication 8, comportant par ailleurs les étapes qui consistent
 - à produire une demande d'information concernant un sujet prédéterminé;
 - à produire des poids pour le contexte de dialogue sur la base de la demande d'information produite; et
 - à pondérer au moins deux de ces facteurs de manière différente sur la base des poids produits pour le
 10 contexte de dialogue.
- 10 10. Procédé d'analyse de la parole selon la revendication 7, comportant par ailleurs l'étape qui consiste
 - à utiliser le processeur d'information de contexte essentiellement en parallèle pour effectuer l'étape (b).
- 15 11. Procédé d'analyse de la parole selon la revendication 1, comportant par ailleurs les étapes qui consistent
 - à produire des scores pour les étiquettes; et
 - à sélectionner les N meilleures étiquettes qui vont être utilisées dans la représentation analysée sur la base
 20 des scores produits.
- 20 12. Procédé d'analyse de la parole selon la revendication 11, comportant par ailleurs les étapes qui consistent
 - à effectuer les étapes (b) et (c) avec une pluralité d'itérations; et
 - à utiliser les N meilleures étiquettes sélectionnées d'une première itération comme éléments d'entrée liés
 25 au traitement des étapes (b) et (c) d'une deuxième itération.
- 25 13. Procédé d'analyse de la parole selon la revendication 1, **caractérisé en ce que** les étiquettes indiquent les sujets des grammaires.
- 30 14. Procédé d'analyse de la parole selon la revendication 1, **caractérisé en ce que** la phrase à l'entrée est grammaticalement incorrecte en ce qui concerne au moins une partie de cette phrase à l'entrée, le procédé comportant par ailleurs les étapes qui consistent
 - à produire une pluralité de forêts d'analyse liées à la phrase à l'entrée, qui est grammaticalement incorrecte,
 - en utilisant des grammaires;
 - à associer des étiquettes avec des mots dans la phrase à l'entrée, qui est grammaticalement incorrecte, en
 - utilisant les forêts d'analyse produites; et
 - à utiliser les étiquettes associées à ces mots en tant que représentation analysée de la phrase à l'entrée qui
 35 est grammaticalement incorrecte.
- 40 15. Procédé d'analyse de la parole selon la revendication 1, **caractérisé en ce que** ces grammaires se basent sur des grammaires sensibles au contexte gauche-droite.
- 45 16. Procédé d'analyse de la parole selon la revendication 1, **caractérisé en ce que** ces grammaires se basent sur des grammaires sensibles au contexte gauche-droite et contiennent des ambiguïtés.
- 50 17. Procédé d'analyse de la parole selon la revendication 1, comportant par ailleurs les étapes qui consistent
 - à filtrer la phrase à l'entrée au moyen de filtres lexicaux; et
 - à produire la pluralité de forêts d'analyse sur la base de la phrase à l'entrée filtrée.
- 55 18. Procédé d'analyse de la parole selon la revendication 1, comportant par ailleurs l'étape qui consiste
 - à extraire des composantes sémantiques de la phrase à l'entrée sur la base des étiquettes associées à ces
 mots.
19. Procédé d'analyse de la parole selon la revendication 1, comportant par ailleurs l'étape qui consiste
 - à fournir un analyseur global pour extraire les composantes sémantiques de la phrase à l'entrée sur la base
 des étiquettes associées à ces mots.
20. Procédé d'analyse de la parole selon la revendication 19, comportant par ailleurs l'étape qui consiste
 - à gérer, sur la base des composantes sémantiques extraites, l'échange de dialogue entre un dispositif de
 reconnaissance de la parole et un utilisateur.

21. Procédé d'analyse de la parole selon la revendication 19, comportant par ailleurs l'étape qui consiste à gérer, sur la base des composantes sémantiques extraites, l'échange de dialogue entre deux utilisateurs qui parlent des langues différentes.
- 5 22. Dispositif d'analyse de la parole mis en oeuvre par ordinateur, servant à traiter une phrase à l'entrée, comportant des moyens de fournir une pluralité de grammaires (140, 142) indiquant des sujets prédéterminés; un générateur de forêts d'analyse servant à produire une pluralité de forêts d'analyse (150, 152) liées à la phrase à l'entrée (118) en utilisant ces grammaires; un générateur d'étiquettes servant à associer des étiquettes (164, 166) à des mots dans la phrase à l'entrée
10 (118) en utilisant les forêts d'analyse produites (150, 152); un générateur de scores pour étiquettes servant à produire des scores pour ces étiquettes (164, 166) sur la base des attributs des forêts d'analyse; et un sélecteur d'étiquettes servant à sélectionner des étiquettes qui seront utilisées comme représentation analysée (180) de la phrase à l'entrée (118) sur la base des scores produits.
15
23. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** le générateur de forêts d'analyse est exécuté avec une pluralité d'itérations de telle sorte que chaque itération produit d'autres forêts d'analyse.
- 20 24. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** le générateur de forêts est exécuté avec une pluralité d'itérations de telle sorte que chaque itération produit d'autres forêts d'analyse relativement à chacune des grammaires.
- 25 25. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** le générateur de scores pour étiquettes produit des scores pour les étiquettes sur la base de certains facteurs fonction des scores qui sont sélectionnés dans le groupe composé du nombre de terminaux, de la taille des intervalles, de la profondeur, du nombre de non terminaux, et de combinaisons de ceux-ci.
- 30 26. Dispositif d'analyse de la parole selon la revendication 25, **caractérisé en ce que** le générateur de scores pour étiquettes pondère au moins deux des facteurs de manière différente.
- 35 27. Dispositif d'analyse de la parole selon la revendication 26, **caractérisé en ce que** le générateur de scores pour étiquettes se sert de l'information de contexte pour pondérer au moins deux des facteurs de manière différente.
- 40 28. Dispositif d'analyse de la parole selon la revendication 27, comportant par ailleurs un module de reconnaissance de la parole pour assurer la reconnaissance vocale de la phrase à l'entrée et pour produire un vecteur de confiance dans les mots pour la phrase à l'entrée essentiellement, le générateur de scores pour étiquettes assurant la pondération d'au moins deux des facteurs de manière
45 différente sur la base du vecteur de confiance dans les mots qui est produit.
- 50 29. Dispositif d'analyse de la parole selon la revendication 27 ou la revendication 28 comportant par ailleurs un gestionnaire de dialogue qui produit une demande d'information concernant un sujet prédéterminé, ce gestionnaire de dialogue produisant des poids pour le contexte de dialogue sur la base de la demande d'information produite, le générateur de scores pour étiquettes assurant la pondération d'au moins deux des facteurs de manière
55 différente sur la base des poids produits pour le contexte de dialogue.
30. Dispositif d'analyse de la parole selon la revendication 22, comportant par ailleurs un générateur de scores pour étiquettes servant à produire des scores pour les étiquettes; et un sélecteur d'étiquettes servant à sélectionner les N meilleures étiquettes qui seront utilisées dans la représentation analysée sur la base des scores produits.
31. Dispositif d'analyse de la parole selon la revendication 30, **caractérisé en ce que** le générateur de forêts d'analyse et le générateur d'étiquettes sont exécutés avec une pluralité d'itérations, les N meilleures étiquettes sélectionnées d'une première itération étant utilisées comme éléments d'entrée pour le générateur de forêts d'analyse et le
60 générateur d'étiquettes au cours d'une deuxième itération.
32. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** les étiquettes indiquent les sujets des grammaires.

- 5 33. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** la phrase à l'entrée est grammaticalement incorrecte en ce qui concerne au moins une partie de cette phrase à l'entrée, les générateurs de forêts d'analyse produisant une pluralité de forêts d'analyse liées à la phrase à l'entrée, qui est grammaticalement incorrecte, en utilisant ces grammaires, et le générateur d'étiquettes qui associe les étiquettes avec les mots dans cette phrase à l'entrée, qui est grammaticalement incorrecte, utilisant ces forêts d'analyse produites, ces étiquettes étant associées aux mots en tant que représentation analysée de la phrase à l'entrée qui est grammaticalement incorrecte.
- 10 34. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** ces grammaires se basent sur des grammaires sensibles au contexte gauche-droite.
35. Dispositif d'analyse de la parole selon la revendication 22, **caractérisé en ce que** ces grammaires se basent sur des grammaires sensibles au contexte gauche-droite et contiennent des ambiguïtés.
- 15 36. Dispositif d'analyse de la parole selon la revendication 22, comportant par ailleurs un filtre lexical servant à filtrer la phrase à l'entrée, le générateur de forêts d'analyse produisant la pluralité de forêts d'analyse sur la base de la phrase à l'entrée filtrée.
- 20 37. Dispositif d'analyse de la parole selon la revendication 22, comportant par ailleurs un extracteur sémantique servant à extraire les composantes sémantiques de la phrase à l'entrée sur la base des étiquettes qui sont associées à ces mots.
- 25 38. Dispositif d'analyse de la parole selon la revendication 37, comportant par ailleurs un analyseur global servant à extraire les composantes sémantiques de la phrase à l'entrée sur la base des étiquettes qui sont associées à ces mots.
- 30 39. Dispositif d'analyse de la parole selon la revendication 38, comportant par ailleurs un gestionnaire de dialogue servant à assurer la gestion, sur la base des composantes sémantiques extraites, de l'échange de dialogue entre un dispositif de reconnaissance de la parole et un utilisateur.
- 40 40. Dispositif d'analyse de la parole selon la revendication 39, comportant par ailleurs un gestionnaire de dialogue servant à assurer la gestion, sur la base des composantes sémantiques extraites, de l'échange de dialogue entre deux utilisateurs qui parlent des langues différentes.

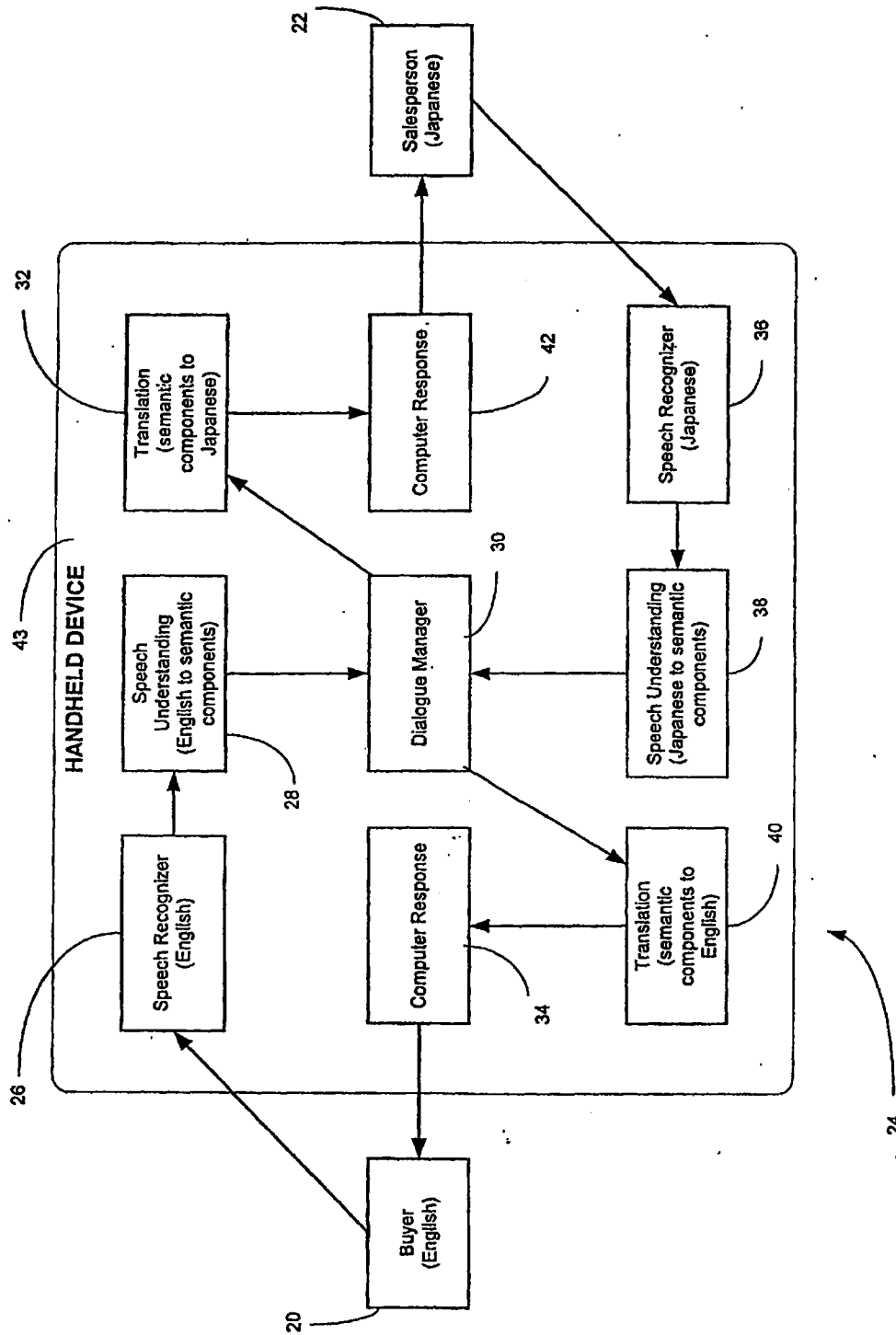
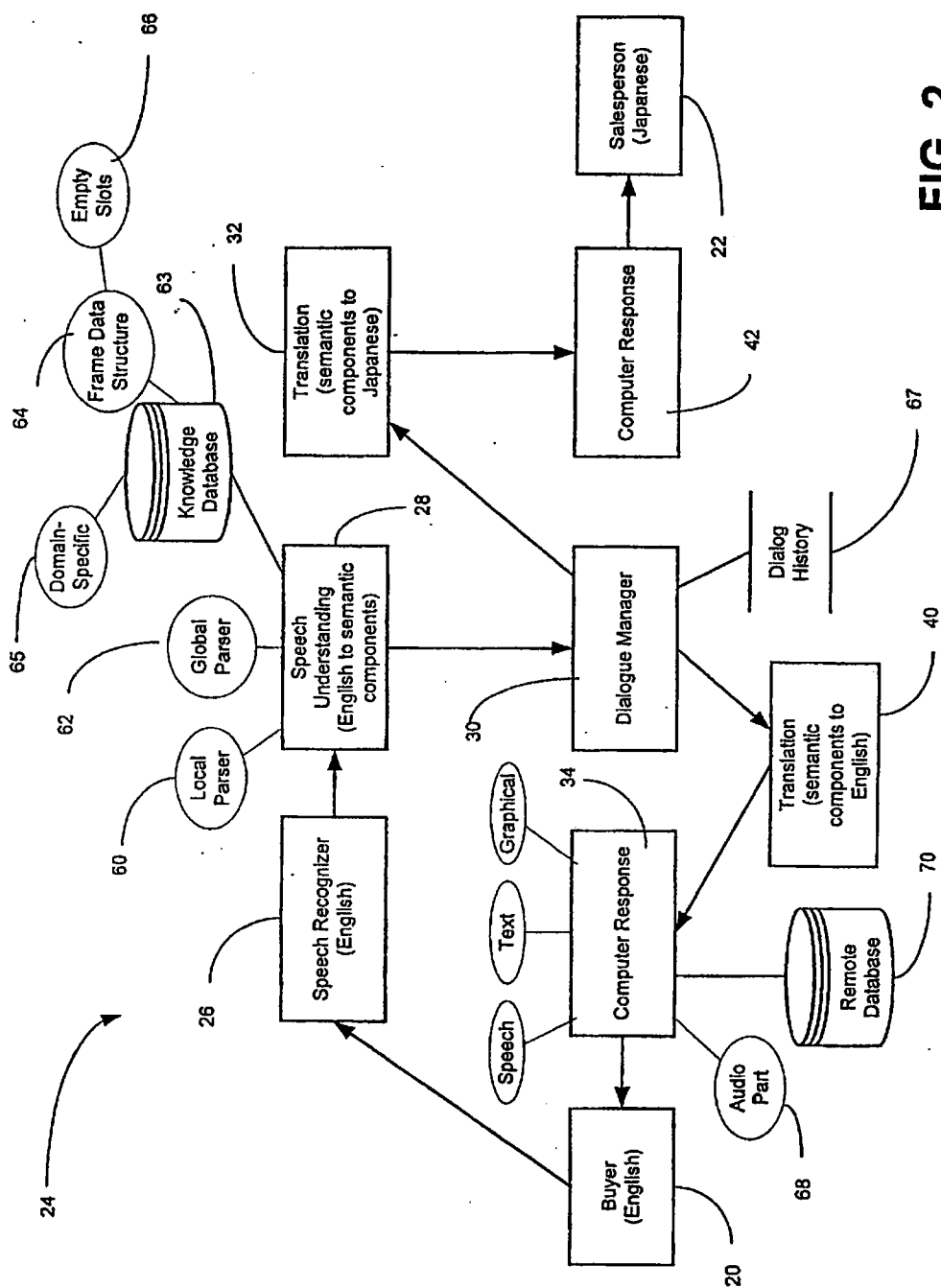


FIG. 1

**FIG. 2**

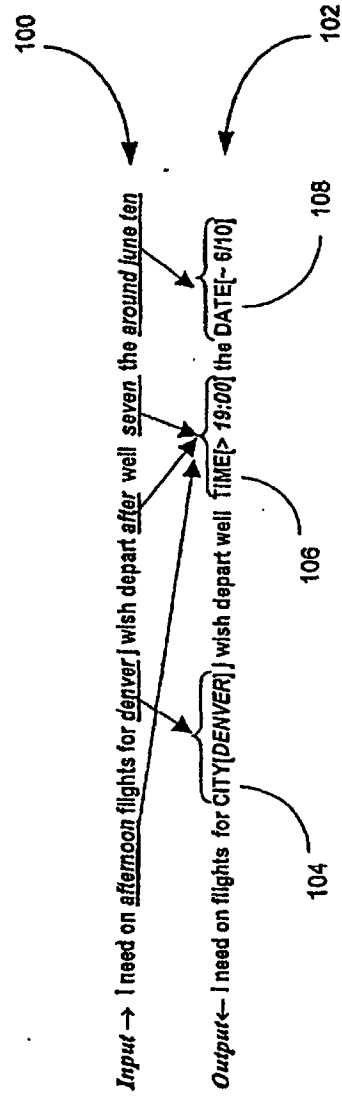
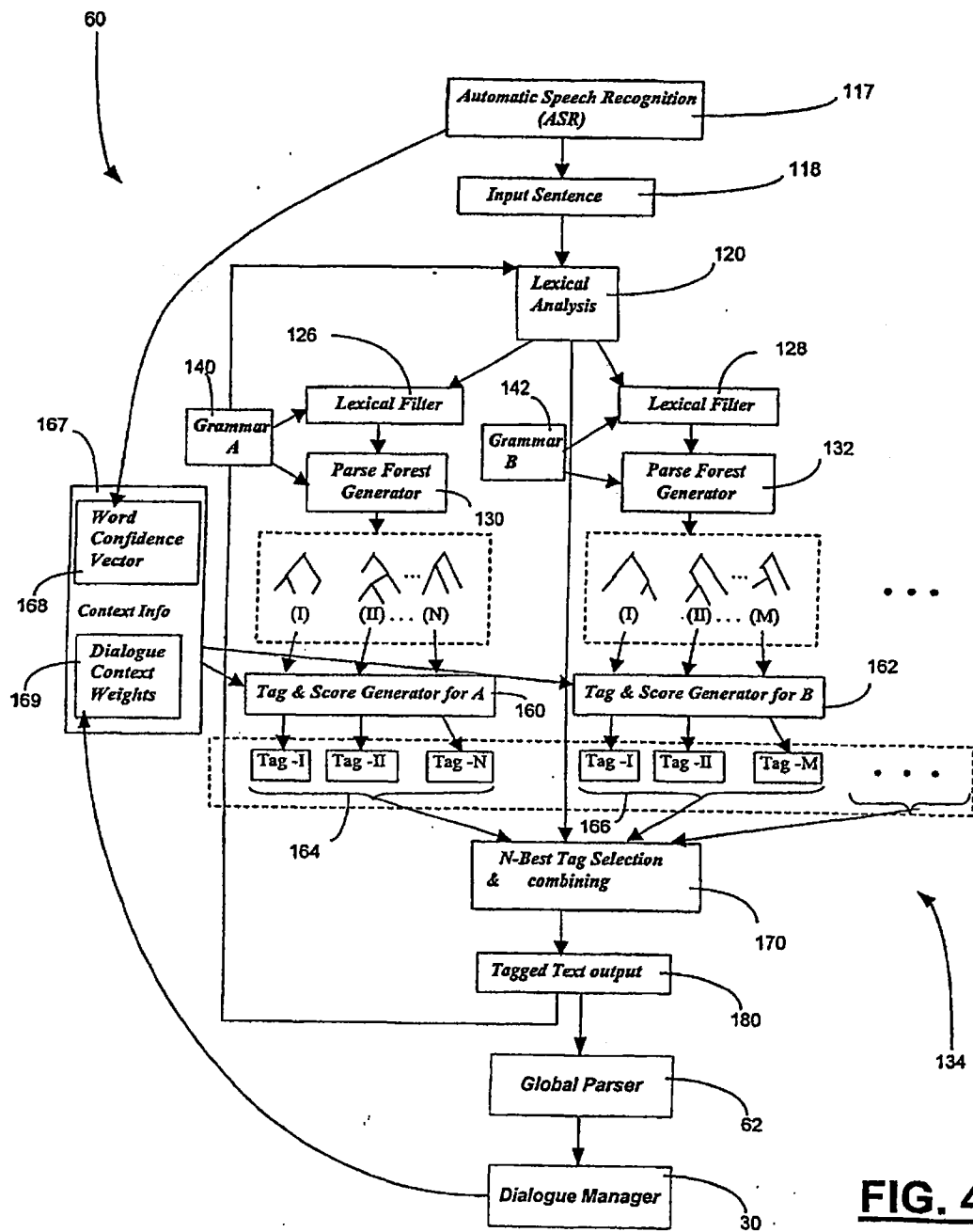


FIG. 3

**FIG. 4**

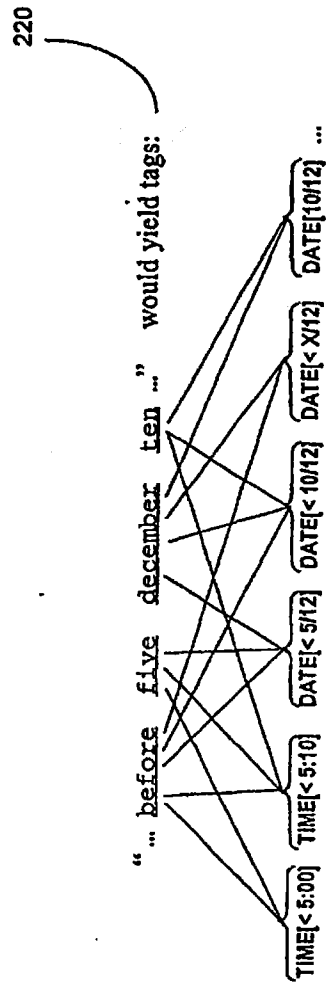


FIG. 5

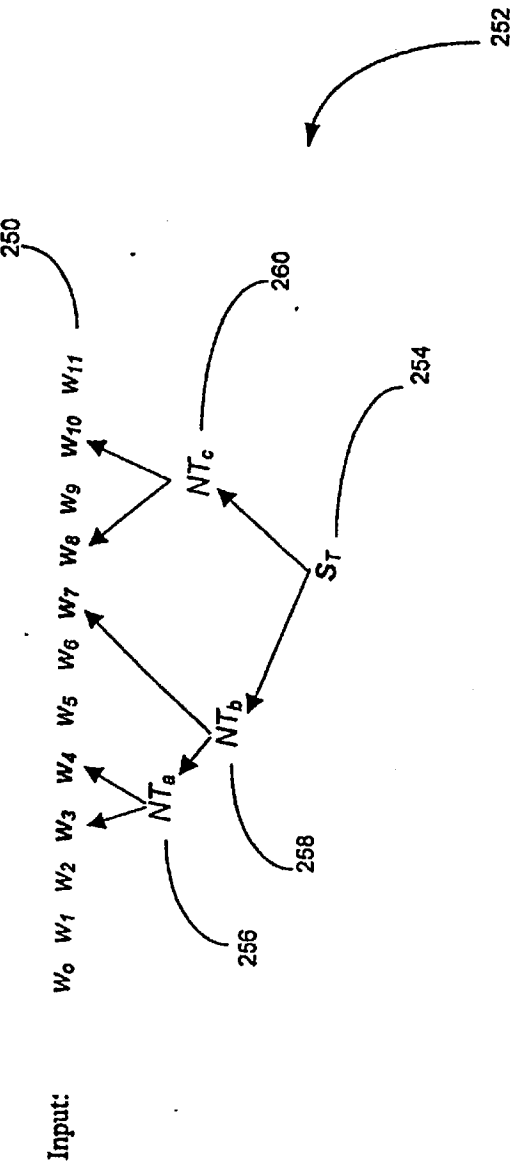


FIG. 6

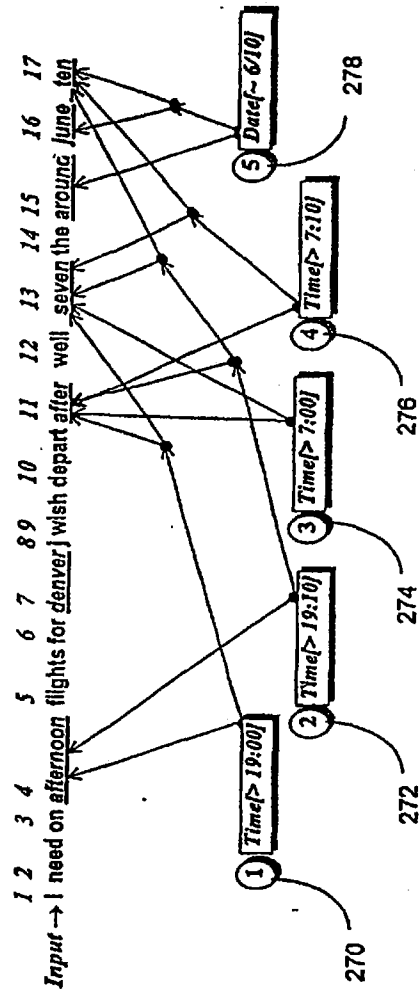
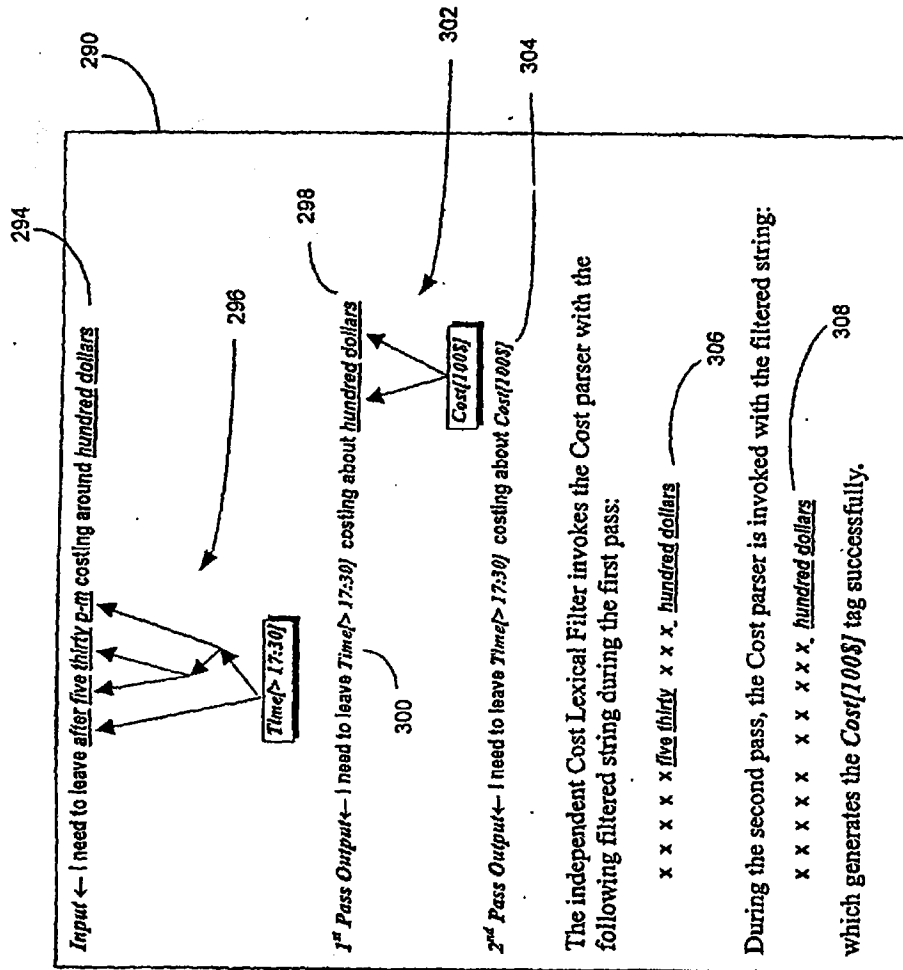


FIG. 7

**FIG. 8**

```

* COST.
320 COST = C_Core.
    C_Core = C_Gen |
            C_Phr |
            C_Qualified |
            C_Interval |
            X C_Core |
            C_Core X.
    C_Gen = C_Num |
            C_Num C_Currency.
324 C_Num = C_Thousands C_Hundreds C_Tens |
        C_Thousands C_Hundreds |
        C_Thousands |
        C_Hundreds C_Tens |
        C_Hundreds |
        C_Tens |
        X C_Num.
    C_Thousands = C_Tens c_thousand |
                c_thousand.
    C_Hundreds = C_Tens c_hundred |
                c_hundred.
    C_Tens = c_num |
            c_num c_numToTen.
    C_Currency = c_yen |
                c_dollar |
                X C_Currency.
    C_Phr = c_cheapest | c_least | c_least
            c_expensive.
    C_Qualified = c_qualifier C_Gen.
    C_Interval = c_between C_Gen C_Gen.
    X = x | X x.
    XX = x x | x.
    c_yen: yen yens.
    c_dollar: dollar dollars.
328 c_cheapest: cheapest.
    c_least: least.
    c_expensive: expensive.
    c_qualifier: under below less.
    c_between: between.
    c_thousand: thousand.
    c_hundred: hundred.
    c_num: one two three four five six seven
            eight nine ten eleven
            twelve thirteen fourteen fifteen
            sixteen seventeen
            eighteen nineteen twenty thirty forty
            fifty sixty seventy
            eighty ninety.
    c_numToTen: one two three four five six
                seven eight nine.
    x.

```

FIG. 9

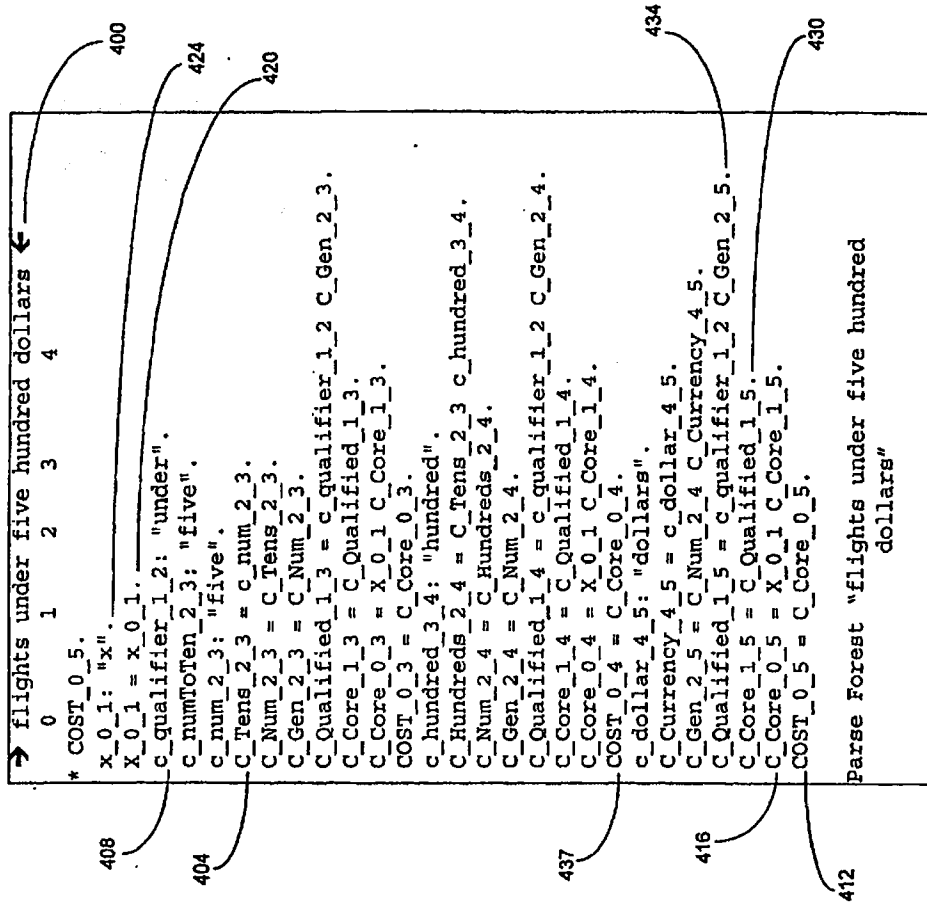


FIG. 10

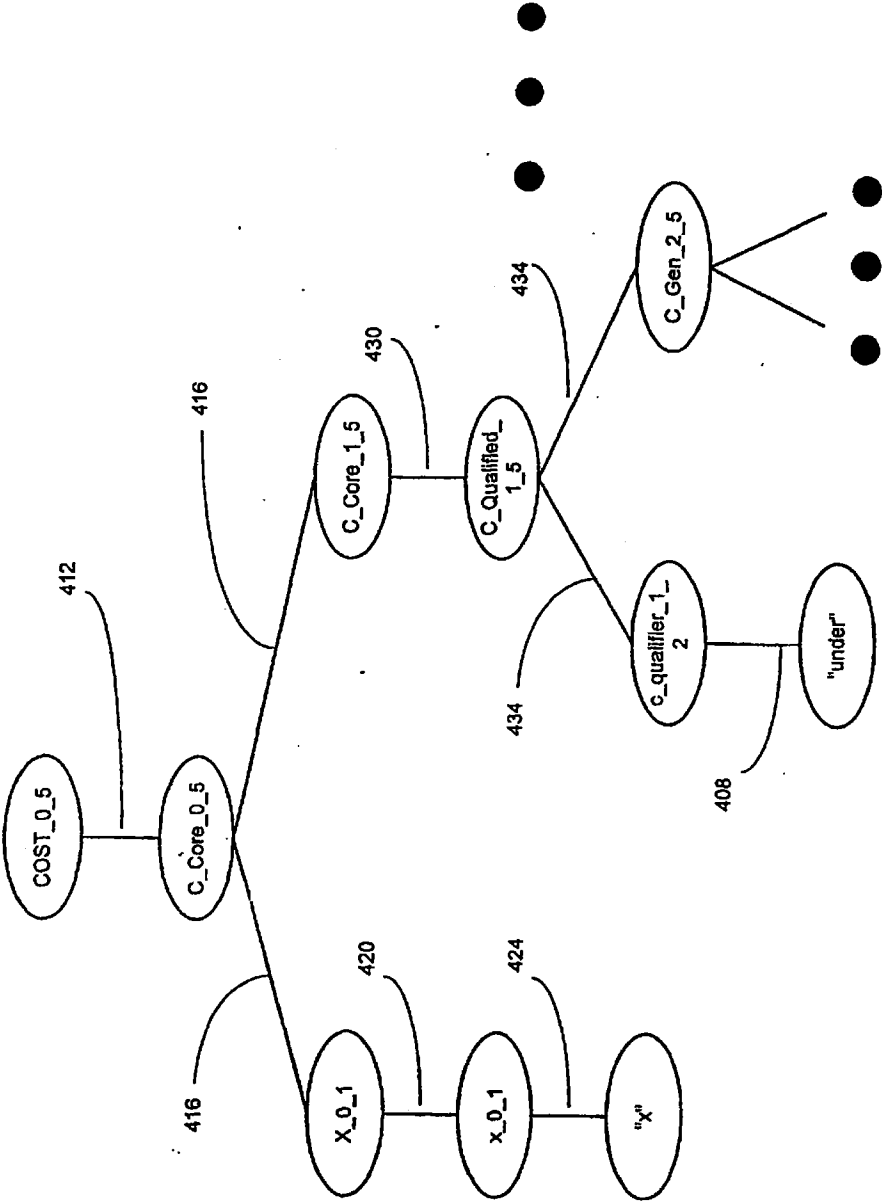


FIG. 11

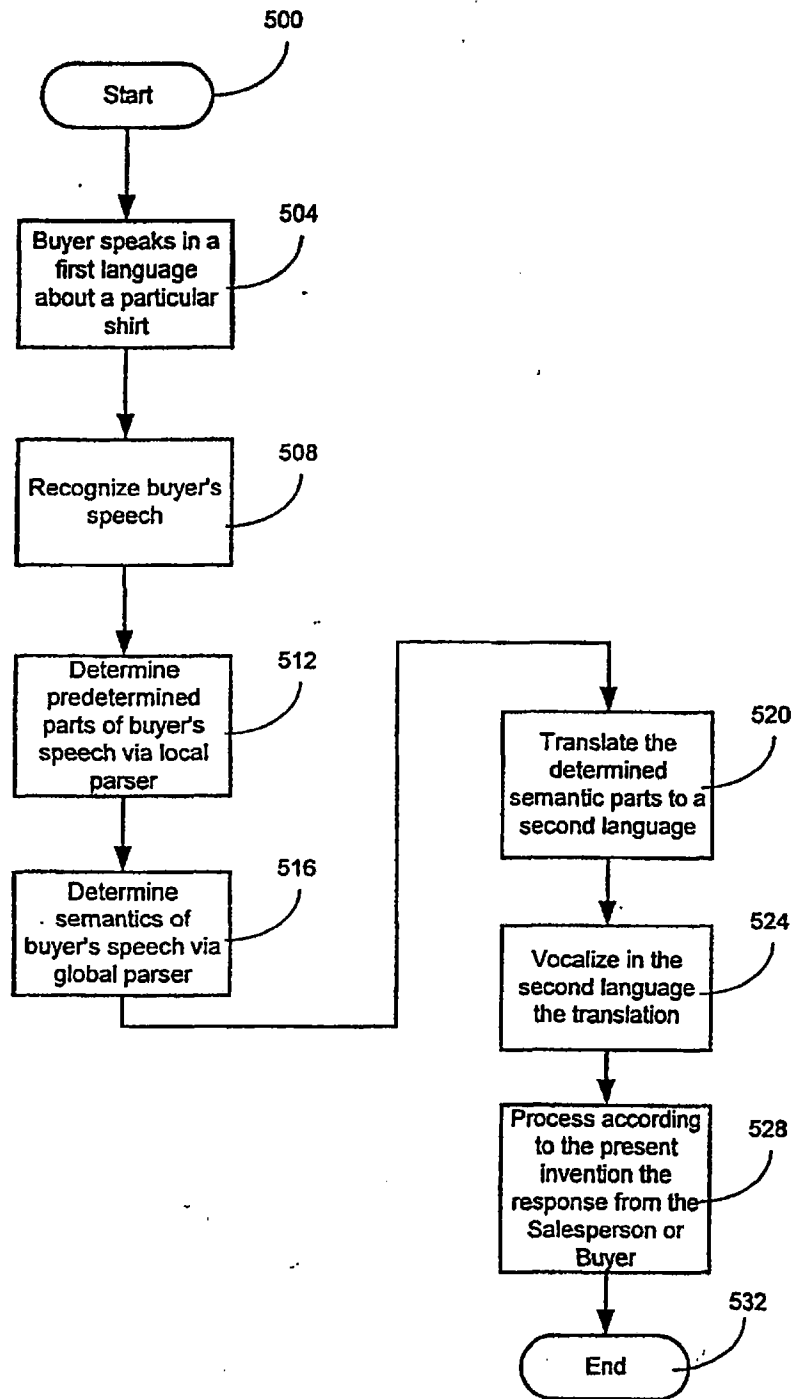
**FIG. 12**

FIG. 13